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Prevalence of Bovine Hydatidosis and Its Economic Significance in Harar Municipality Abattoir, Eastern Ethiopia

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Abstract: A cross-sectional study of bovine hydatidosis was conducted in Harar Municipality Abattoir from December 2013 to March 2014 to estimate the prevalence and economic impact of hydatidosis in cattle slaughtered at Harar Municipality Abattoir. Abattoir survey of hydatidosis was conducted on 679 cattle encountered at Harar Municipality Abattoir on three regular weekly visits over the study period. Ante-mortem examination was conducted to note the breed, age, sex and body condition of study animals. Post mortem examination was conducted to note the presence and load of hydatid cysts. A total of 77 (11.3%) cattle were affected with hydatid cyst. Females were affected more frequently than males ($P<0.05$). However, no such association was observed in prevalence of hydatid cysts and age, breed and body condition of study animals. Fifty five (8.1%), 52 (7.6%), 3 (0.4%) and 26 (6.77%) study animals had hydatid cysts in their lungs, livers, spleen and both lung and liver, respectively. Majority of hydatid cysts evaluated in this study were of medium 28 (38.9%) and small 27 (37.5%) size with the remaining 17 (23.6%) being of large size. Meanwhile, 37 (51.4%) of the hydatid cysts were found to be fertile, 19 (26.4%) were sterile and 16 (22.2%) were calcified. The annual economic loss due organ condemnation associated to bovine hydatidosis at the abattoir was estimated 96, 315.00 Ethiopian Birr (ETB) (4,815.75 US Dollar; 1USD= 20.00 ETB). It was concluded that, hydatidosis was one of the most important parasitic diseases in cattle slaughtered at Harar municipality abattoir and thus it deserve due attention to safeguard public health.

Key words: Prevalence · Hydatidosis · Cattle · Abattoir · Harar · Financial Loss

INTRODUCTION

Hydatidosis or Cystic Echinococcosis (CE) is a chronic zoonotic disease condition associated to infection with the larval stage (hydatid cysts) of the dog tapeworm *Echicoccus granulosus* (*E. granulosus*) [1]. Dogs are the primary definite host for the parasite while livestock and human are intermediate hosts [2]. Hydatidosis occurs throughout the world and causes considerable economic losses and public health problems [3, 4]. The highest incidence is reported mainly from sheep and cattle rearing areas [5]. Despite substantial research and control efforts hydatidosis remains endemic in many livestock rearing area of the world and inflicts public health problems in the Middle East, Mediterranean, Central and South America, Asia and Africa, including Ethiopia [6, 7]. Moreover, cystic Echinococcosis caused by *E. granulosus* is a re-emerging disease in places where it was previously at low levels [8].

Although *E. granulosus* penetrates deep between the villi of the small intestine of the definitive host, there are no pathogenic effects even in heavy infections, suggesting that infected definitive hosts are asymptomatic carriers of the parasite. Furthermore, infections with *E. granulosus* cysts in the intermediate host are typically asymptomatic, except for a small number of cases with chronic and heavy infections. There are no reliable methods for the routine diagnosis of infections in living animals, but in rare cases cysts have been identified by ultrasonography alone or in conjunction with serum antibody detection [9]. A new ELISA with a high specificity and a sensitivity of 50% to 60% might be useful for detecting *E. granulosus* cysts in sheep on a flock basis but cannot be used for a reliable diagnosis of infected individuals [2]. The most reliable diagnostic method is cyst detection during meat inspection or at post-mortem examination.

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Cystic Echinococcosis in farm animals causes considerable economic problems due to loss of edible livers and also significant losses of meat and milk production [3, 4, 9]. Studies have concluded that hydatidosis caused by *E. granulosus* can result in a 10% decrease in whole of life performance for infected animals (reduction in quality of meat, production of fiber, production of milk and in number of surviving offspring) [4]. However, these figures are not well-known to third world farmers and are probably insignificant in the face of pandemics of infectious disease and losses due to reproductive diseases, parasitism and starvation. Therefore, all programs of hydatid control around the world have been driven by the zoonotic status of the parasite and concerns for human health [10, 11].

Hydatidosis has been known and documented in Ethiopia as early as 1970; it is still the major cause of organ condemnation in most Ethiopian abattoirs and lead to huge economic losses in the livestock sector [12]. Hydatidosis is widely prevalent in livestock population of various region of Ethiopia [6]. Epidemiological determinants of bovine hydatidosis are prevalent in Harari region. Harar city, where the current study is conducted, is one of the UNESCO registered city in Ethiopia. Despite this fact, there is no clear picture regarding the extent of bovine hydatidosis and associated economic losses in the region. Therefore, the present study aimed in determining the prevalence of hydatidosis and estimating the direct economic losses due to cattle hydatidosis at Harar municipality abattoir.

MATERIALS AND METHODS

Study Area: The present study was carried out in Harar, capital city of Harari Regional State, 525 Km east of Addis Ababa the capital city of Ethiopia. The region is situated at 41°59' 58''N latitude and 9°24'10'' longitudes. The climate of the State is one of the most pleasant in the country. Temperature is even between 17.1°C-20.2° C throughout the year. The average annual intensity of precipitation ranges between 750-1,000 mm.

Study Desig: A cross sectional study design was used to examine the prevalence of bovine hydatidosis and its economic significance in Harar municipality abattoir. The abattoir survey was complimented by a characterization of hydatid cyst size and fertility.

Study Population: The study population included all cattle brought for slaughter to Harar municipality abattoir during the study period. This population comprised of cattle of different breed, gender and age composition originating from different districts of Harari region.

All visceral organs affected by the cyst and their respective cystic content in cattle brought to slaughter at the abattoir during the study period was considered as a sampling population for selection of cysts used in characterization of physical size and fertility status.

Sampling Method and Sample Size: Sampling of study animals for the abattoir survey was conducted by randomized systemic sampling method i.e. regular abattoir visit on 3 alternating days of the five weekly slaughter days. All cattle brought for slaughter on selected working days were considered for subsequent survey of hydatidosis. Determination of sample size was done according to Thrusfield [13] and taking a 20.05% expected prevalence [14], 95% confidence interval and 5% desired absolute precision. Accordingly, the calculated sample size was found to be 246. However, to increase the precision of the study, a total of 679 cattle were randomly sampled.

Sampling of cysts for physical size and fertility characterization study was done purposively by taking the most prominent superficial hydatid cysts from 72 randomly selected hydatidosis positive bovine visceral organs.

Study Methods

Ante-Mortem Examination: Physical clinical examination of study animals was done prior to slaughter to record the breed, sex, age and body condition status of study animals. The age of cattle was determined by dental examination according to De Launta and Habel [15] and animals were subjectively classified as young (< 5 yrs) or adult (> 5 yrs). Body condition (nutritional status) of cattle was subjectively classified as poor (hide bound with obvious bony prominences and deep sunk tail base), medium (ribs and other bony prominences noticeable on visual inspection but have fair fleshy background on palpation) or good (bony structures notable only on palpation).

Post-Mortem Examination: Important visceral organs (lung, liver, heart, spleen and kidney) of all study animals were inspected by visual inspection, digital palpation and systematic incision to detect presence of hydatid cysts. The total number of hydatid cysts in each affected organ was noted to calculate the load of burden on organ and study animal level.

Measurement of Cyst Size: Assessment of the physical development pattern of hydatid cysts was conducted based on caliper measurement of the diameter of 72 superficially prominent cysts (on different organs). Accordingly, hydatid cysts were classified into three groups as small (diameter <4cm), medium (diameter 4-6cm) and large (diameter >6cm) according to Kebede, Mitiku, Tilahun and Oostburg, Vrede, Bergen [16, 17].

Examination of Cyst for Fertility: Assessment of the fertility status of hydatid cysts was conducted based on laboratory examination of the contents of 72 superficially prominent cysts (on different organs). The cyst wall was then penetrated and the contents were transferred into a sterile petridish then the content was examined under a microscope (40x). Based on the presence or absence of brood capsules containing protoscolices in hydatid fluid, cysts were identified and classified as fertile, sterile and calcified according to the method described by Torgerson, Budke [18].

Estimation of Financial Losses Due to Bovine Hydatidosis: To estimate the economic losses associated to bovine hydatidosis, only direct losses associated to condemnation of locally usable visceral organs (liver and lung) was considered. Five different meat vendors were interviewed randomly to establish the price per unit organ and the average organ price was determined and used as price index to calculate financial losses due to organ condemnation as per [19]. Denbarga (2011). Average annual slaughter rate of cattle in Harar municipality abattoir was estimated from secondary data for the past three years. Using current organ condemnation rates and price indices combined with annual cattle slaughter rate at the abattoir (secondary data), annual economic losses associated to bovine hydatidosis was calculated in terms of Ethiopian Birr according to the method employed by Ogunrinade, Ogunrinade [20].

Annual economic loss = (PI1x TkxC1) + (PI2xTkxC2) + (PI3xTkxC3))

where,

PI1 = Percent involvement of lung out of the total examined

PI2 = Percent involvement of liver out of the total examined

PI3 = Percent involvement of spleen out of the total examined

C1 = Average market price of liver

C2 = Average market price of lung

C3 = Average market price of spleen

Tk = Average annual kill of bovines

Data Management and Statistical Analysis: The data collected from abattoir survey and physical evaluation of hydatid cysts was entered on to Microsoft excel spreadsheets and analyzed using SPSS version 20. Associations between explanatory variables (age, sex, breed and body condition score) and prevalence was done by chi-square (X^2) test. $P<0.05$ was set as cut point indicating significant variation (association) [13].

RESULTS

Description of Study Cattle: An abattoir survey of Hydatidosis was conducted in 679 cattle over the period from December, 2013 to March, 2014. 652 (96%) study cattle were indigenous breeds whereas 27(4%) were exotic cross bred cattle. 396 (58.3%) of the animals were males and the remaining 283 (41.7%) were females. 217 (32%) of the study cattle were young and the remaining 462 (68%) adult. 126 (18.6%) 261 (38.4%) and 292 (43%) of the study animals had poor medium and good body conditions, respectively.

Epidemiology of Hydatid Cysts: A total of 77 (11.3%) study cattle were affected by hydatid cysts. Frequency of abattoir hydatid cyst finding was relatively higher in the month of March 8 (13.6%), followed by December 30 (13%), February 23 (10.2%) and January 16 (9.8%) (P=0.659).

Hydatid Cysts Organ Affection Pattern: Generally, 47 (6.9 %) cattle had affection of one organ (liver or lung) whereas 30 (4.4%) had affection of multiple organ systems. The lung was the most frequently affected body organ 55 (8.1%) followed by liver 52 (7.6%) and spleen 3 (0.4%). Meanwhile, no hydatid cysts were detected on the hearts and kidneys examined. There was no significant difference in organ affection patter of the cysts among animals of different breed, sex, age group and body condition status (Table 2).

A total of 289 hydatid cysts were detected in 110 organs from 77cattle. The average load of hydatid cysts was 3.75 ± 0.4 cysts/ animals and some animals carried as many as 22 hydatid cysts overall. A total of 151 hydatid cysts were detected in 55 affected lungs.

Table 1: Prevalence of hydatid cysts according to breed, age, sex and body condition of cattle.

Animal factor	Categories	Prevalence of hydatid cyst	p -Value
Breed	Indigenous	75(11.5 %)	0.511
	Exotic	2 (7.4 %)	
Sex	Male	36 (9.1 %)	0.029
	Female	41 (14.5 %)	
Age group	Young	20 (9.2 %)	0.232
	Adult	57 (12.3 %)	
Body condition	Poor	17 (13.5 %)	0.577
	Medium	26 (10 %)	
	Good	34 (11.6 %)	

Table 2: Prevalence of hydatid cysts according to study cattle

		Organ affection frequency (N (%))				
Animal type		None	Lung	Liver	Spleen	p value
Breed	Local (652)	577 (88.5)	53 (8.1)	52(8)	3(0.5)	0.515
	Exotic (27)	25(92.6)	2(7.4)	0	0	
Sex	Male (396)	360 (90.9)	25 (6.3)	26 (6.6)	1 (0.3)	0.210
	Female (283)	242 (85.5)	30 (10.6)	26 (9.2)	2 (0.7)	
Age group	Young (217)	197 (90.8)	14 (6.5)	13 (6.1)	1 (0.5)	0.783
	Adult (462)	405 (87.7)	41 (8.8)	39 (8.4)	2 (0.4)	
Body	Poor (126)	109 (86.5)	14 (11.2)	11(8.8)	1 (0.8)	0.783
Condition	Medium (261)	235 (90)	19 (7.2)	17(6.5)	0	
	Good (292)	258(88.4)	22(7.5)	24(8.2)	2(0.7)	

Table 3: Load of hydatid cysts according to study cattle

		Load hydatid cysts per animal/organ (Mean ± SE)		
Animal type		Overall	Lung	Liver
Breed	Local (72)	3.8 ± 0.4	1.9 ± 0.2	1.8 ± 0.2
	Exotic (2)	2 ± 1	2 ± 1	0
Sex	Male (36)	3.8 ± 0.5	1.9 ± 0.3	1.9 ± 0.3
	Female (38)	3.7± 0.6	2 ± 0.3	1.6 ± 0.3
Age group	Young (19)	3.9 ± 0.5	2.3 ± 0.4	1.5 ± 0.3
	Adult (55)	3.7 ± 0.5	1.8 ± 0.3	1.8 ± 0.3
Body	Poor (17)	4.8 ± 1.1	2.8 ± 0.6	1.3 ± 0.3
	Medium (24)	3 ± 0.3	1.7 ± 0.3	2 ± 0.22
	Good (33)	3.8 ±0.7	1.7 ± 0.3	1.9 ± 0.4

Table 4: Size and fertility of hydatid cysts according to type of organ affected

		Organs		
Type of Hydatid cysts		Liver (31)	Lung (38)	Spleen (3)
Size	Small	13 (41.9)	14 (36.8)	0
	Medium	13 (41.9)	12 (31.6)	3(100)
	Large	5 (16.1)	14 (36.8)	0
Fertility	Calcified	9(29)	7 (18.4)	0
	Sterile	11(35.5)	8 (21.1)	0
	Fertile	11(35.5)	23 (60.5)	3 (100)

Table 5: Financial impact of organ condemnation due to Hydatid cysts during the study period

		Unit price (Birr/ organ)		
Organ	Condemned rate (N)	Range	Mean	Total cost of organ
Lung	55/679 (8.1%)	20 - 30	25	1,300.00
Liver	52/679 (7.6%)	65 - 125	95	4,560.00
Overall financial losses (Ethiopian Birr)				5,890.00

The load of hydatid cysts per affected lung ranged from 1 to 10 with an average of 2.7 ± 0.27. The majority of affected lungs had a single (30.4%), two (30.4%) or three-five (30.4%) cysts. 5.4 % and 3.6% of the affected lungs had six and ten hydatid cysts, respectively. 133 hydatid cysts were detected from 52 affected livers. The load of hydatid cysts per affected liver ranged from 1 to 10 with an average of 2.56 ± 0.26. A single, two, three, four, six and ten hydatid cysts were observed in 26.9%, 34.6%, 21.2%, 11.5%, 1.9% and 3.8% of the affected lungs, respectively. On the other hand only a single (33.3%) or two (66.7%) hydatid cysts were detected on three affected spleens. In all cases, affection of the spleen was associated with heavy presence of hydatid cysts (4-10) on both the lungs and the liver. No significant association was observed between different animal factors and hydatid cyst load (Table 3).

Size and Fertility of Hydatid Cysts: Gross evaluation of the size and fertility of hydatid cysts was conducted on 31 (59.6%) of the livers, 38 (69%) of the lungs and 3 (100%) of the spleens affected by hydatidosis. Majority of hydatid cysts evaluated in this study were of medium 28 (38.9%) and small 27 (37.5%) size with the remaining 17 (23.6%) being of large size. Meanwhile, 37 (51.4%) of the hydatid cysts evaluated were found to be fertile, 19 (26.4%) were sterile and 16 (22.2%) were calcified. The type (size and fertility) of hydatid cysts did not vary from organ to organ (Table 4).

Economic Impact of Organ Condemnation Due to Hydatid Cysts: A total of 110 cattle organs were condemned as unacceptable for use by humans or animal. The overall monetary loss associated to organ condemnation due to hydatid cysts in the present study was around 5,890 Birr (Table 5). The annual bovine slaughter rate in the Harar municipal abattoir for the period from 2011 to 2013 was 10,356 animals / year. Considering the current price indices and condemnation rate for liver (7%) and lung (7.6%), the annual monetary losses associated to condemnation of bovine liver and lung due to hydatid cyst in Harar municipal abattoir amount to 75,344.00 Birr and 20,971.00 Birr respectively.

DISCUSSION

This study revealed that bovine hydatidosis is a significant disease in Harar with the prevalence rate of 11.3%.(n=679) which is comparable with similar studies conducted in Mizan Tepi (11.26%) by Jemere *et al.* [21], in Burdur (Turkey) 13.5% by Umur [22], Umur (2003) and in Thrace (Turkey) 11.6% by Esatgil, Tuzer [23]. However, this prevalence was lower than several studies conducted in south Wollo (17.95%) by Degefu, Damet [24], in Arbaminch municipalty abattoir (20.50%) by Tilahun, Terefe [25], in Tigray municipalty abattoir (22.98%) by Kebede *et al.* [6] in Jimma municipality abattoir (36.3%) [26]. This variation in prevalence of hydatidosis could be due to several factors of which husbandry systems, hygiene differences, strains difference in *E. granulosus* that exist in different geographical situations, difference in culture, social activity and attitude to dog in study area.

The prevalence of hydatidosis in female animals (14.5%) found to be significantly higher than the male animals (9.1%) ($p<0.05$). Similar finding has been reported in Zambia by Banda *et al.* [27]. This might be attributed to management practices of male and female cattle. Milking cow usually managed around homesteads for milking purposes which expose them to come in contact with infected dogs. There was no statistical variation in the prevalence rates between the different breed, body condition and age groups.

In the current study, the lung was the most frequently affected body organ (8.1%) followed by liver 52(7.6%) and spleen 3(0.4%). This result is agreed with other studies in cattle by Degefu, Damet and Tilahun, Terefe and Abera, Teame, Sheferaw [24, 25, 26]. This could be due to the fact that liver and lung are the first large capillary fields encountered by the blood born onchosphere and the lungs have larger capillary bed than any other organ. This could account for the observed higher prevalence than seen in other organs.

The average load of hydatid cysts in infected cattle was 3.75±0.4. With regard to organs, the average load was 2.7±0.27 in lung and 2.56±0.26 in liver. The mean number of cysts found in this study was very close to

the findings of Kebede *et al*. [6] who reported on overall average of 3.8 hydatid cysts per organ and 4.61and 3.24 for lung and liver respectively.

Out of the total 72 randomly collected hydatid cysts 38.8%, 37.5% and 26.41% were medium, small and large sized cysts respectively. Medium and small size cysts have higher proportion than large sized cysts. This indicated that the immunological response of the hosts which might have reduced the expansion of cyst size or due to infection of animals as a result of heavy rain falls and continuous grazing in the past rainy seasons [12].

The fertility rate of cysts among the organ was found higher in lungs (60.5%) compared to liver which was (35.5%). This finding was in agreement with the reports of Mulatu *et al.* and Abera, Teame, Sheferaw and Terefe *et al.* [14,26, 28], who reported higher fertility rate in lung than liver. This could be due to the relatively soft consistency of lung tissue which allows the easier development of the cyst. The greater prevalence and higher fertility of pulmonary cyst over hepatic cyst of cattle indicate the importance of internal organs as potential source of infection to dogs.

No significant differences in hydatid cyst prevalence was observed between body conditions. However, higher prevalence was observed in cattle having poor (13.5 %) than good (11.6 %)) body condition.

The annual economic loss due to bovine hydatidosis at Harar municipality abattoir from direct losses from organ condemnation was estimated to be 96,315.00 Birr. The total annual loss could be greater than the estimated amount of bearing in mind that this only took into account direct losses and not indirect losses as a result of weight loss due to hydatidosis and other losses such as reduced milk production and reduction in reproduction in cattle. This finding of annual economic losses is much higher than the report of Degefu, Damet [24] who reported annual economic losses, due to direct loss from organ condemnation of 6,280 Birr at Elfora Kombolcha meat factory and 23,876 Birr by Mulatu *et al.* [14] in Eastern part of Ethiopia at Dire Dawa municipality abattoir. The variation might be due to prevalence difference in various abattoirs\regions, variations in mean annual number of cattle slaughtered in different abattoirs, variations in the retail market price of organs and high demand of edible offal's and beef in the study area.

CONCLUSION

From the present study, it can be concluded that hydatidosis was one of the most important parasitic diseases in cattle slaughtered at Harar municipality abattoir. The observed overall prevalence was comparable with other studies. The lung and liver were the most frequently affected body organs. In terms of frequency and fertility of the cyst the lung was found to be the most preferred predilection site. The huge financial losses due to organ condemnation reflect the economic impact of hydatidosis which deserves serious attention by the various stakeholders. In light of the above conclusion the following recommendations were forwarded: a control program should be designed and implemented to reduce the number of stray dogs, proper disposal of infected organs in abattoir, regular deworming of household dogs and raise the awareness of abattoir workers and butchers on the public health significance of condemned offals.

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